Suggested Assessment Types and Item Specifications for Mathematics

The following are examples of assessment types that were developed to reflect the nature, depth and breadth of the Maine *Learning Results* in Mathematics. Table 1 provides a general description of each assessment type, some example MAP or LAD assessments that meet the items specifications for the assessment type, and a sample distribution. Neither the sample assessment types nor the sample distribution should be interpreted as **requirements**, but rather representations of the variety of strategies available to capture the depth and breadth of Maine's *Learning Results* as you consider the concepts of "Form and Function". Tables 2 – 4 are item specifications for each of the assessment types listed, and provide guidance for developing assessments locally. The packet contains examples of each assessment type after the item specifications. The MAP and/or LAD tasks that are used as examples of item types in this packet should not be construed as suggestions for a distribution of assessments for certification. It should also be noted that additional assessments are currently under development

Table 1: Example Mathematics Assessment Types with Example Items *

Mathematics Item Type	Example Assessments
Bundle: A bundle is a set of questions comprised of any* combination of selected responses, short answer responses, and short constructed responses. A bundle may assess a single performance indicator or up to two related performance indicators. Bundles should have a minimum of 12 units (internal score points) for each performance indicator being measured with each selected response question worth 1 unit, each short answer question worth 2 units, and each short constructed response worth 4 units. A minimum of 12 units is required to ensure the bundle contains sufficient evidence to make a decision regarding level(s) of performance on the performance indicator(s) being measured. * A bundle consisting of only selected response questions is not recommended.	Grades K-2 ❑ Bugs ❑ Pumpkin Patch Grades 3-4 ❑ A's and B's ❑ Moving Those Shapes Grades 5-8 ❑ Calculations w/o Calculators ❑ Lucky Draw Grades 9-12 ❑ Which Base Bundle ❑ Ode to a Fraction
Structured Response: A structured response assessment is defined by students being provided a set of guiding questions and/or formats in which to respond to a topic or problem. To respond to this assessment type, the student does not have to make decisions about the questions that need addressing, or the format in which to respond. The cognitive demand of the question increases across the assessment. A structured response should include both content and process demand either by assessing content standard J and/or K or by those indicators with implicit process expectations- see attachment "Additional Process Indicators for Mathematics". A mathematics Structured Response can assess either an application of the mathematics in a "real world" context, or a set of concepts.	Grades K-2 ❑ Cookies ❑ Band-Alien Grades 3-4 ❑ Seashell Collection ❑ Alphabet and Animal Pattern Grades 5-8 ❑ Canoes for Rent ❑ Chessboard Grades 9-12 ❑ Buying a Jet Ski ❑ The Number Line

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Projects:	
Exploratory Project I: Statistical Study In a statistical study students identify a question/ issue/claim or are given one by the instructor to address. Students design the data collection tools or protocols, collect the data, organize and appropriately display the data to address the question or issues. Students analyze the data and draw conclusions based upon the findings.	None currently available in the LAD or MAP item banks.
Exploratory Project II: Concept Development Students identify or are provided with a concept to study. There are two aspects to this project: 1) Fully explaining the concept using models and other representations on a poster and in a written report. 2) Providing examples of how the concept is applied.	
Exploratory Project III: Measurement Project: There are two types of Measurement Projects: **1) 2- or 3 – D Model:** Students are asked to make a three-dimensional scale model of an object. The volume and surface area of the object are to be calculated. At the middle level, making a 2-D model, i.e. a house floor plan with perimeter and area calculations would be an appropriate task. **2) Formula derivation:** Students are to demonstrate how area and volume formulas are derived using models, diagrams, and explanations (middle and high school only).	
Exploratory Project IV: Conjecture and Proof After inductive exploration, students develop a conjecture that they either prove or disprove with a counterexample. The conjecture is often revised or refined on the "road to a conclusion." Presentation of results may be in the form of a written explanation, but an oral presentation and defense may be more appropriate (high school). At the middle level, students may make conjectures and refute them by counterexample or "justify" their belief in the truth of the conjecture without the level of proof that would be expected in high school.	See enclosed example.
Exploratory Project V: Mathematical Models After data collection, students develop equation, simulation, or vertex-edge graph models that describe the phenomenon observed and may be used to make predictions based on given conditions. Key to this project are: clear identification of what variables and constants refer to and limitations of the model (for what values of the domain the model is reasonable). This is appropriate for middle level and high school students.	See enclosed example.

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Table 2: Bundle Item Specifications

Bundle	**Recommended Cluster/Standards/Performance Indicators Assessed**	**Recommended Structure/Format/Setting**	**Example MAP or LAD Assessments**
General Description: A bundle is a set or assortment of selected response and/or short answer questions, in combination with a set of short constructed response (application*) questions that assess a single performance indicator that has multiple components, or multiple related performance indicators. Other bundles may be comprised of a series of physical measurements within an application process that covers the range of the indicator. * An "application" is a short constructed response question, roughly equivalent to an MEA 4-point constructed response.	**Mathematics**: All content standards except J. .	**Students Interaction:** Student responds to prompt. **Structure:** • Each component in a bundle should include a series of questions that relate to a single performance indicator or related performance indicators. • The format of the questions could include a combination of selected response, short answer, and constructed response but should not be limited to selected response. • A bundle may assess more than one performance indicator, but each should be fully developed. • An opportunity to exceed the standard (get a "4") should be a part of the bundle design. **Interaction of process and content:** Bundles assess only content performance indicators or suitable indicators from K. **Setting:** Bundles should be administered within the class setting.	See enclosure

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Table 3: Structured Response Item Specifications

Structured Response	Recommended Cluster/Standards/Performance Indicators Assessed	Recommended Structure/Format/Setting	Example MAP or LAD Assessments
General Description: A structured response assessment is defined by students being provided a set of guiding questions and/or formats in which to respond to a topic or problem. To respond to this assessment type, the student does not have to make decisions about the questions that need addressing, or the format in which to respond. The cognitive demand of the question increases across the assessment. A structured response should include both content and process demand either by assessing J and K or by the implied cognitive demand of the performance indicators assessed.	Reasoning (Mathematical Decision Making) and Communication (Patterns) are standards that are features of <u>most</u> structured responses. Computation should be counted or scored only in structured responses where an extensive amount of computation is required. A structured response may have a significant amount of reasoning and/or communication required to align the task with the cognitive demand of the content indicator. Alignment with indicators from standards J and K are not necessary.	**Student interaction**: Students respond to a given prompt(s). The work method is prescribed as to which standard will be demonstrated within the response **Structur**e: A prompt or set of prompts that describes a problem situation and asks for a student response with a clear expectation of what is expected of students. The item prompts and may be scored on process (Reasoning and/or Communication) and one to three content performance indicators. **Interaction of process and content:** Most structured response questions require students to demonstrate achievement in both process and content either through the direct assessment of performance indicators J or K, or through the cognitive demand implied in the performance indicator assessed. **Setting:** Structured response items are treated as a whole. The items usually take more than one class period to complete and may require extended time.	**Examples** See enclosure **Points:** Depending on the number of dimensions (indicators) tested a structured response ranges from 8 (2 dimensions) to 16 (4 dimensions) points.

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Table 4: Mathematical Projects Item Specifications

Mathematical Project Statistical Study	**Clusters**	**Structure**	**Points Possible**
General Description: Key to the Statistical Study is student identification of a question, design of a method to collect data, choice of method to organize and analyze data, and drawing of (probable) conclusions. Because of this high demand and complexity, indicators in Standard C are best assessed in structured response or bundles in elementary grades.	**Statistical Studies** assess Standards C and J in the Mathematical Decision Making Cluster. Standard K may also be central to a study at the middle level.	**Students Interaction:** Students may select the topic or the teacher may assign the topic or project to be completed. Students choose methods to use. Students work independently. **Structure:** Students identify or are provided with a question/claim, devise a study to evaluate the claim/question, collect appropriate data to study the claim/question, appropriately represent data collected, and draw conclusions. The product is a written summary of the question/ claim that was studied. **Interaction of Content and Process:** In a statistical study, statistical techniques are used to handle data to support making a decision based on statistical reasoning. **Setting:** Projects are developed over an extended period of time.	**Points:** Variable, usually 12-20 points .

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Table 4: Mathematical Projects Item Specifications continued

Mathematical Projects Concept Development	**Clusters**	**Structure**	**Points Possible**
General Description: The concept development project is based on independent learning. Students research a topic and then create a poster and report to demonstrate their understanding of the concept and its applications.	**Concept Development Projects**: All clusters, all performance indicators.	**Student Interaction:** Students may select the topic or the teacher may assign the topic or project to be completed. Students work independently. **Structure:** Students identify or are provided with a concept to study. There are two aspects to this project: 1 Fully explaining the concept using models and/or other representations on a poster and in a written report. 2) Providing examples of how the concept is applied. **Interaction of Content and Process:** In the project, students develop an understanding of the new content and then go the next step, showing deep understanding as they explain the concept and develop models for the concept. In addition, the students must demonstrate how the concept can be applied. **Setting:** Projects are developed over an extended period of time.	**Points:** 8 – 16 points .

Table 4: Mathematical Projects Item Specifications continued

Mathematical Projects Measurement	**Clusters**	**Structure**	**Points Possible**
General Description: Measurement projects take on the two faces of measurement – using measurement tools and calculating measures that cannot be measured directly. Measurement projects require multiple steps and decisions on the students' part as to how to proceed.	**Measurement Projects**: Shape and Size Cluster	**Student Interaction:** Students may select the topic or the teacher may assign the topic or project to be completed. Students work independently. **Structure:** There are two types of Measurement Projects: 1) **2-D and 3-D Model:** Students are asked to make a three-dimensional scale model of an object. The volume and surface area of the object are to be calculated. At the middle level, making a 2-D model, i.e. a house floor plan with perimeter and area calculations would be an appropriate task. 2) **Formula derivation:** Students are to demonstrate how surface area and volume formulas are derived using models, diagrams, and explanations. **Interaction of Content and Process:** In measurement projects there is knowledge – units and formulas, techniques – the use of tools and calculation, and the process of deciding how to proceed using which units, which formulas and which tools. In type 1, all of this is put together to create a product of specified size and shape. The physical artifact shows the skill. In type II, understanding of the geometry of the situation is coupled with known formulas to produce a new formula. The constructed formula, along with the explanation reveals understanding. **Setting:** Projects are developed over an extended period of time.	**Points:** 8-12 points .

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Table 4: Mathematical Projects Item Specifications continued

Mathematical Projects Conjecture and Proof	**Clusters**	**Structure**	**Points Possible**
General Description: Students develop or are provided with a hypothesis or conjecture, which they either prove or disprove. In the elementary and middle grades, justification for beliefs may replace formal proof.	**Conjecture and Proof Projects**: All clusters, In elementary and middle grades Standard J in the Mathematical Reasoning Cluster is required. In high school indicators E2 and K1 may be featured.	**Student Interaction:** Students may select the topic or the teacher may assign the topic or project to be completed. Method of proof is not scaffolded, but format may be prescribed. Students work independently. **Structure:** This project type is most appropriate to middle level and high school grade spans. At the middle level, students are expected to support or justify their reasoning with models, known facts, properties, and relationships. At the high school level, more formal proof should be expected. A written product should be produced. Student "defense" of their work may, but does not have to, be a feature. The product would be a written report, with an oral defense optional. To be a project rather than a structured response the method of proof should not be scaffolded. **Interaction of Content and Process:** Justification and proof are processes central to mathematics. These process cross content boundaries. The content provides the facts needed to build the argument about the truth or falsity of a conjecture. **Setting:** Projects are developed over an extended period of time.	**Points:** 8-16 points

Suggested Assessment Types and Item Specifications for Mathematics

Table 4: Mathematical Projects Item Specifications continued

Mathematical Projects Mathematical Modeling	**Clusters**	**Structure**	**Points Possible**
General Description: Mathematical models are equation or other representations that have key features of the phenomenon or situation being studies. The models can be manipulated in the "math world" and the mathematical result interpreted as a possible "real world" solution.	**Mathematical Modeling Projects:** Emphasis will be on indicators from the Patterns Cluster and from Standard I (Discrete Mathematics) in the Number and Operations Cluster.	**Student Interaction:** Students may select the topic or the teacher may assign the topic or project to be completed. Students work independently without significant scaffolding. **Structure:** Students create a mathematical equation, simulation or vertex-edge graph to "model" an actual situation. Developing, manipulating and then evaluating the model's results or value are critical components. The model must identify important features of the situation and account for them. The product includes a description of the situation modeled, any data collected, the model, an explanation of how the parts of the model (numbers, variables, actions, edges, etc.) match the situation, a description of how the model may be used to make predictions and limitations of the model. This is most appropriate to middle level and high school. **Interaction of Content and Process:** Mathematical modeling is a process. A math representation is created to capture the salient features of a situation. The students use the techniques and concepts of algebra or discrete mathematics, applying mathematical methods to the mathematical form. Once a result is obtained, the student must evaluate the mathematical result in the "real world" context. **Setting:** Projects are developed over an extended period of time.	**Points:** 8-16 points